



**Otoacoustic Emissions,  
A New Tool  
for Hearing Conservation Testing  
(Reprint)**

**By**

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**Aircrew Protection**



19950719 058

**April 1995**

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SECURITY CLASSIFICATION OF THIS PAGE

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS		
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2b. DECLASSIFICATION / DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAARL Report No. 95-22			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Aeromedical Research Laboratory		6b. OFFICE SYMBOL (If applicable) MCMR-UAD	7a. NAME OF MONITORING ORGANIZATION U.S. Army Medical Research and Materiel Command		
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8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO. 62787A	PROJECT NO. 30162787A878	TASK NO. HC
			WORK UNIT ACCESSION NO. 144		
11. TITLE (Include Security Classification) Otoacoustic emissions, a new tool for hearing conservation testing					
12. PERSONAL AUTHOR(S) Mason, Kevin T., and Ribera, John E.					
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM TO		14. DATE OF REPORT (Year, Month, Day) 1995 April	
				15. PAGE COUNT 4	
16. SUPPLEMENTAL NOTATION Reprint from the U.S. Army Aviation Digest, March/April 1995, pp. 22-23.					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	otoacoustic emission, audiogram, hearing conservation		
06	04				
06	05				
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Researchers at the U.S. Army Aeromedical Research Laboratory are investigating a revolutionary hearing test called otoacoustic emissions (OAEs). With OAE testing, an Army aircrew member's annual hearing test will be reduced to listening passively to a few tones for a few seconds. The paper describes the method of conducting OAE testing and presents figures to demonstrate findings. The advantages of OAE are tabulated.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Chief, Science Support Center			22b. TELEPHONE (Include Area Code) (334) 255-6907		22c. OFFICE SYMBOL MCMR-UAX-SS

# **Otoacoustic Emissions, a New Tool for Hearing Conservation Testing**

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## **Annual hearing test**

It is time for your annual hearing test. You sit in a booth. The air is stale and stuffy. You put on the familiar earphones. Make sure you have got the red one on the right ear. You grab a button in your hand and wait for tone pulses. You get the attention of the tester, "Wait, I'm tangled in these wires." There it is, a tone, and you press the button. Darn, somebody just moved . . . was that a tone? The tones get fainter and fainter. Click, click. You are straining to hear that very distant tone. Beep, beep, beep. Bang, somebody kicked the booth. Thinking to yourself, "I missed that tone. Boy, it is getting hot in here. I can not believe how loud that high-pitched whine is getting in the background. Is that the machine or me? This is not going so well." Minutes go by. Click, click. Finally, it is over. Okay, you passed!

## **Introduction**

U.S. Army Aeromedical Research Laboratory (USAARL) scientists are investigating a revolutionary hearing test called otoacoustic emissions (OAE). With

OAE testing, your annual hearing test will be reduced to listening passively to a few tones for a few seconds. And, no more button pressing!

## **OAE method**

An OAE ear piece is placed comfortably in the ear. It has a miniature sound source that emits two tone pulses of different frequencies ( $f_1$  and  $f_2$ ) into the ear canal. These are conducted to the inner ear (cochlea). The inner ear is stimulated by the tones and generates a third tone, called a distortion product. The distortion product tone is a biomechanical emission of acoustic energy from the inner ear; hence the name, otoacoustic emissions (ear sound emissions). With hearing loss, the inner ear loses its ability to produce the distortion product tone at affected frequencies.

A miniature microphone in the OAE ear piece detects the stimulation tones and the distortion product tone. In a few seconds, many stimulation tones of varying frequencies are sent into the ear, generating various distortion product tones. Aircrew members do

not have to actively listen for tones and push a button. They just relax, sit still, and the test is over in less than 2 minutes.

A computer measures the original stimulation tones and the distortion product tones. The computer makes a two-axis graph. Background noise is plotted on the graph by amplitude in decibels and by frequency in Hertz. The amplitude of the distortion product tone is plotted at the frequency of the second stimulation tone (f2) that caused the distortion tone. Audiologists examine the shape of the plotted curves. They measure the difference between the background noise and the distortion product amplitudes. Figure 1 shows an aircrew member with normal hearing. In contrast, Figure 2 shows an aircrew member with hearing loss. Note how the distortion product curve and the background noise curve approach each other above 3000 Hz in the patient with abnormal hearing. The inner ear is not responding properly to stimulation tones at and above 3000 Hz, producing OAE with reduced amplitudes compared to a patient with normal inner ear function.

### Advantages

Current pure tone testing stations can be upgraded readily to measure OAE. Table 1 shows the advantages of using OAE testing instead of the traditional pure tone testing.

### Validation tests

USAARL is conducting validation OAE tests. We are testing aircrew members of all ages and genders, with a broad range of hearing capabilities. Volunteers will undergo standard audiometric testing, speech

discrimination tests, and OAE tests during short sessions. Data will be examined to find out if new hearing conservation program standards can be based on OAE testing instead of pure tone testing. If you are interested in testing this new technology as a volunteer, contact MAJ Ribera at DSN 558-6823/6804 or COMM (205) 255-6823/6804.

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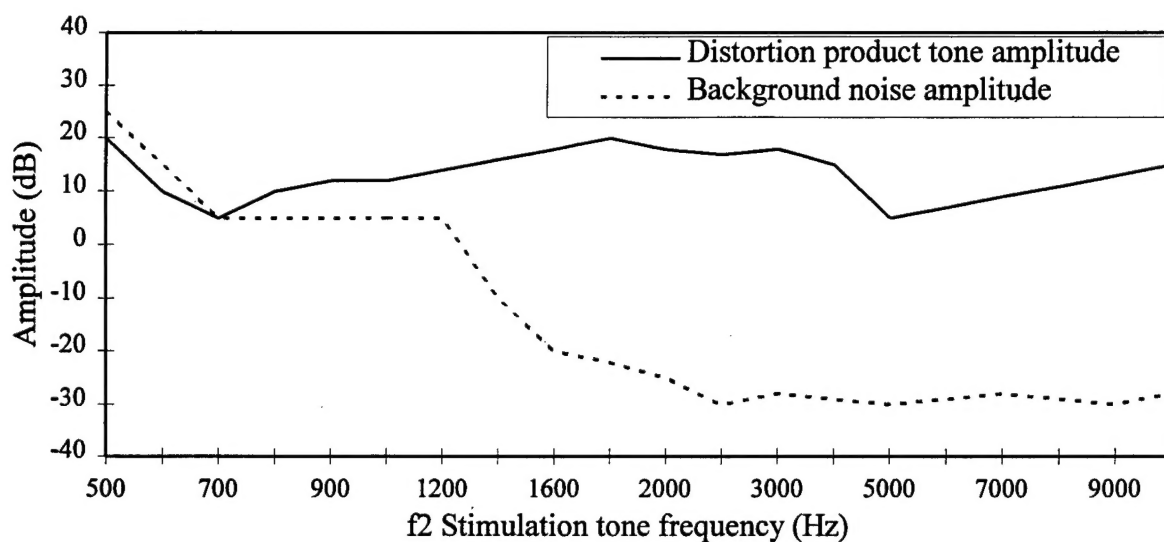


Figure 1. Otoacoustic emissions plot in an aviator with normal hearing.

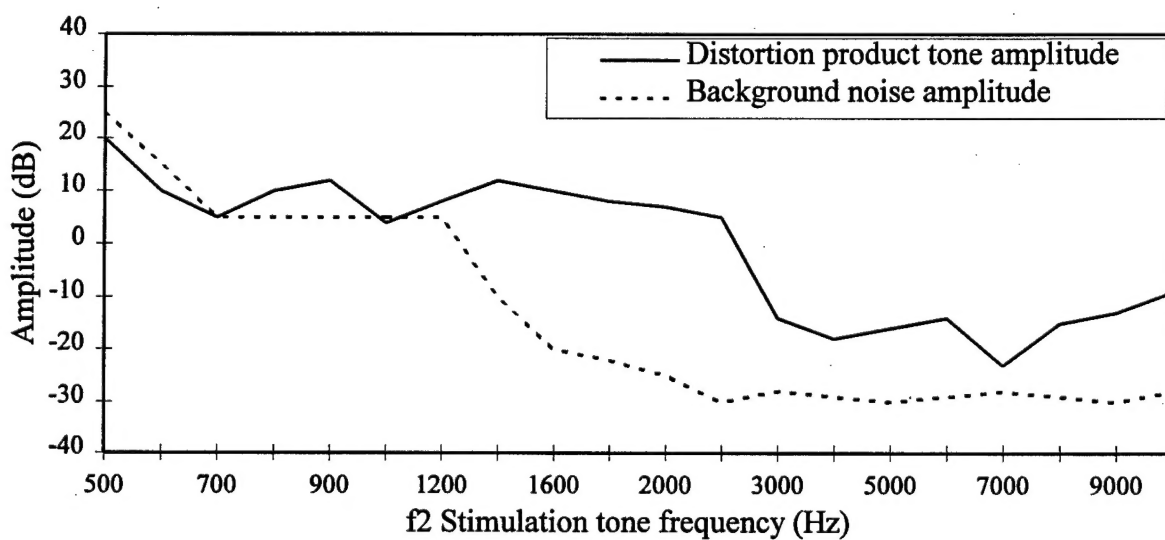


Figure 2. Otoacoustic emissions plot in an aviator with abnormal hearing at and above 3000 Hz.

Table 1.

Advantages of using otoacoustic emissions compared to standard pure tone testing.

- 
- 
1. Simple, passive, automated measure of hearing.
  2. Provides objective results.
  3. Provides frequency-specific measure of inner ear function.
  4. Results are highly reproducible between examinations.
  5. Reliable indicator of noise-induced hearing loss.
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